Quantum Theory, Consciousness, and Being

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Abstract

In [NeuroQuantology **6**, 46 (2008): arXiv:0706.4180], a certain natural phenomenon of self-observing consciousness was shown to be incompatible with the standard axioms of quantum theory. In order to consider a possibility of removing this inconsistency, which arises due to the separation between an observing party and a state vector being observed stated in the quantum theory axioms, we provide a conjecture where 'being', or existence, is identified with the experience of observing the state vector. That is, the observer is not observing the state vector in terms of the relative difference between reference frames, instead, the experience of observing the state vector should define the observer, or being. It is shown that the Heisenberg picture provides a natural description of this conjecture.

1 Introduction

Due to a range of reasons, studies involving mental activities have generally remained unnoticed within the physics research community. However, a mental process is certainly a part of nature and, in principle, should be perfectly described by quantum theory if our universe is indeed quantum mechanical. One of the reasons this part of study was largely ignored by physicists was due to the belief that mental activities should be explained by biological means such as with a better understanding of how a brain works etc. The other reason, related to the first one, was the lack of precise mathematical descriptions of mental states as seen in physical systems such as atoms, electrons etc. In [10, 8, 11], certain natural phenomena were considered where the observer's mental state can be written in precise mathematical terms, just like a state vector for physical systems. Moreover, it was shown that in the case of self-observing consciousness, that is, when the observer is observing his own mental state (also known as 'reflexive self-consciousness"in the philosophy literature [3, 14]), the standard axioms of quantum theory fail to provide a consistent description for this particular phenomenon unlike other natural phenomena.

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This inconsistency is very strange when considering self-observing consciousness as a part of the nature. As will be reviewed, the inconsistency arises from the separation between the observing entity and the object being observed. This separation imposed by the standard axiom of quantum theory insists on a special status for the observing entity among nature, and causes a problem for a natural phenomenon when it is the observer who is observing his own mental state. It will be argued that this inconsistency may be removed by identifying the observer with an experience, i.e., identifying experience as being or existence. Rather than treating an observer and an object separately, the experience of observing the object is conjectured to be identified as the observer, which we will call 'being'. It should be noted that the proposed conjecture in this paper has long been discussed among philosophers including Descartes, Kant, Schopenhauer, and Heidegger (also see some of the recent discussions [5, 4, 1, 2, 14]). In fact, the conjecture resembles the concept of *Da-sein* discussed by Heidegger, which claims that an observer and the observed world are inseparable. In this paper, we do not claim to propose a new philosophical concept. Instead, the main strength of our proposal will be to write the conjecture, which has been discussed for hundreds of years in philosophy, in explicit mathematical formulation: that is, by using the language of quantum theory.

It should be noted that, previously, there have been a number of attempts and proposals to connect consciousness with quantum theory. In particular, people have long suspected that a conscious process, which appears to happen in the brain, may have something to do with quantum theory. Penrose has been advocating [7] a non-computability of consciousness and suggested that microtubuli may have a relevance to this non-algorithmic process. One of the important issues surrounding quantum theory and consciousness has involved the so-called quantum measurement process. Stapp has attempted to utilize this process with the superposed brain states [12, 13]. In [6], Everett's many-worlds interpretation has been applied to study consciousness. In this paper, rather than focusing on the state of the brain, we divide the observing party and the observed into observables and state vectors respectively. That is, the observer corresponds to the observables, and the rest of the Universe is represented through state vectors. This view of taking observables as the observing party and constructing the observer's reference frame from observables has produced quite an interesting result with regard to the cosmological constant problem in physics. In [9], it was shown that construction of the reference frames from observables reveals that not only is the harmonic oscillator fluctuating at the ground level, but so is the reference frame when the measurement is realized. This shows that while vacuum energy calculated from quantum theory diverges to infinity, it is not measurable.

This paper is organized as follows. In sect. 2, we review the incompatibility between the natural phenomenon of self-observing consciousness and the axioms of quantum theory discussed in [10]. We then provide a conjecture, a main result of this paper, that the experience of observing is being in sect. 3. In sect. 4, we discuss a suitable description of the conjecture made in sect. 3 is the Heisenberg picture with time going backwards. We conclude with a summary

and comments.

2 Incompatibility between Consciousness and Quantum theory

In [10], it was shown that following the standard axioms of quantum theory leads to the inconsistent description of the natural phenomenon of self-observing consciousness because the two equivalent approaches do not yield an identical description. In this section, we review the discussion in [10] and, in particular, wish to discuss why the standard axioms of quantum theory are inconsistent with the natural phenomenon of self-observing consciousness. We first state the four standard axioms of quantum theory as follows:

(A1) State vector: A state vector, or a qubit in Bloch sphere notation, is written as a unit vector as follows: $\hat{\mathbf{v}} = (\mathbf{v}_x, \mathbf{v}_y, \mathbf{v}_z)$.

(A2) Observables: For a single qubit, an observable can also be written as a unit vector, $\hat{\mathbf{e}} = (\sin\vartheta\cos\varphi, \sin\vartheta\sin\varphi, \cos\vartheta)$.

(A3) Measurements: A measurement is performed on $\hat{\mathbf{v}}$ with respect to an observable $\hat{\mathbf{e}}$, and the average value of eigenvalue outcomes corresponds to the expectation value $\hat{\mathbf{e}} \cdot \hat{\mathbf{v}}$.

(A4) Dynamics: Time evolution of a quantum dynamics is described by an unitary operator U through two equivalent approaches.

We note that in **(A3)**, the axiom with measurement, an entity that performs the measurement and an object, i.e., a state vector, that is being measured are separated. The axiom does not speak of the particular nature of the entity that performs a measurement. Nevertheless, the axiom certainly puts the entity that performs the measurement on a special status. With the example of a natural phenomenon to be presented below, it can be shown that because of this separation, there is symmetry between an entity that performs a measurement and an object being observed such that there are two equivalent approaches, i.e., the Schrödinger and the Heisenberg pictures, in describing the unitary dynamics involving a quantum system, as described in **(A4)**.

With these four axioms **(A1)-(A4)**, we examined the following two natural phenomena:

(**N1**) *An observer observes the rotation of* $\hat{\mathbf{v}}$ *by* χ *about y-axis with respect to* $\hat{\mathbf{e}}$*, followed by a measurement on* $\hat{\mathbf{e}}$.

(**N2**) *An observer observes the rotation of* $\hat{\mathbf{e}}$ *by* χ *about y-axis with respect to* $\hat{\mathbf{e}}$.

For simplicity, we will assume that both the state vector and the observable pointing at z-direction initially and the unitary operation to be a rotation about y-axis by χ throughout this paper including **(N1)** and **(N2)**. Let us discuss the natural phenomenon **(N1)** first. Note that the observable $\hat{\mathbf{e}}$ is serving as a reference frame for the observer in **(N1)**. Moreover, unlike directly observed real-valued eigenvalues, the observable $\hat{\mathbf{e}}$ is defined over a complex Hilbert space just like an indirectly observed state vector. Therefore, due to the two stated reasons, the vector $\hat{\mathbf{e}}$ is a mental reference frame for the observer who is observing the evolution of the state vector $\hat{\mathbf{v}}$ in **(N1)**. Moreover, $\hat{\mathbf{e}}$ fully represents the mental state of the observer as far as **(N1)** is concerned. Let us discuss why: note that the state vector $\hat{\mathbf{v}}$ is a full representation of the physical system as far as **(N1)** is concerned because the state vector is a pure state and is disentangled from other states representing other properties of the physical system. The same logic applies to $\hat{\mathbf{e}}$ as well, i.e., since vector $\hat{\mathbf{e}}$ is disentangled from all other vectors, $\hat{\mathbf{e}}$ is a full representation of the observer's mental state as far as **(N1)** is concerned. Both $\hat{\mathbf{v}}$ and $\hat{\mathbf{e}}$ being pure states, the phenomenon described in **(N1)** (as well as **(N2)** since it is a special case of **(N1)**) is a dynamic of a completely closed system.

Therefore, $\hat{\mathbf{e}}$ being the observer's mental state, it can be seen that we are considering two types of consciousness with the two natural phenomena **(N1)** and **(N2)** which can be stated as follows:

1. an observer is conscious of observing a state vector
2. an observer is conscious of observing his own mental state

That is, for the first type of consciousness, observer's mental state, who is conscious of observing the state vector, is the vector $\hat{\mathbf{e}}$. For the second natural phenomenon **(N2)**, the observer who is in the mental state $\hat{\mathbf{e}}$ is observing his own mental state, i.e., $\hat{\mathbf{e}}$. This second type of consciousness is a special case of the first type and could be called self-observing consciousness. Therefore, the natural phenomena **(N1)** and **(N2)** are examples of the first and the second types of consciousness, respectively.

It can be seen that two approaches in quantum theory as in **(A4)** yield the identical description of **(N1)** where both approaches describe the same observer's observation. In the first approach, it is the state vector that is rotated clockwise while the observer's mental reference frame remains still. For the second approach, the observer's mental reference frame is rotated counterclockwise and the state vector is constant. Therefore, in both occasions, the observer would observe the vector being rotated clockwise, a description given in **(N1)**.

However, the natural phenomenon of self-observing consciousness as described in the example **(N2)** is ill-defined in quantum theory, i.e., both approaches do not yield the same observer's observation. It can be seen that in case of self-observing consciousness as described in **(N2)**, the same vector $\hat{\mathbf{e}}$ is serving the role of both a state vector, because it is being observed, and an observable, because it is serving as observer's mental reference frame. In the

first approach, it is the state vector that is rotated. For self-observing consciousness as described in **(N2)**, the state vector corresponds to $\hat{\mathbf{e}}$. Therefore, the state vector $\hat{\mathbf{e}}$ transforms to, $\hat{\mathbf{e}}' = (\sin\chi, 0, \cos\chi)$. In the second approach, it is the observable that is being rotated. According to **(N2)**, the observable is $\hat{\mathbf{e}}$. Therefore, the observer's mental reference frame $\hat{\mathbf{e}}$ is transformed to $\hat{\mathbf{e}}'' = (-\sin\chi, 0, \cos\chi)$. Note that, unlike the case with **(N1)**, both approaches do not yield the same observational phenomenon described in **(N2)** because $\hat{\mathbf{e}}' \neq \hat{\mathbf{e}}''$ unless $\chi = k\pi$ where $k = 0, 1, 2....$ This therefore shows self-observing consciousness as described in **(N2)** cannot be consistently described by axioms of quantum theory.

Moreover, not only did the same vector evolved into two generally different states, but also the evolution of the vector $\hat{\mathbf{e}}$ is physically sensible in neither of the two approaches in quantum dynamics. Using the natural phenomenon **(N1)**, we were able to impose a physical meaning on the two equivalent approaches of quantum theory, i.e., the axiom **(A4)**. However, when it is the observer's own mental state that is evolving, it is not easy to imagine how an observer is able to observe it. We considered the vector in the $x - z$ plane such that initially $\hat{\mathbf{e}}$ is pointing z-direction and with the unitary operation of rotation about y-axis, $\hat{\mathbf{e}}$ evolves under $U = \exp[-i\sigma_y t/2]$ in the first approach. And the final state of $\hat{\mathbf{e}}$ would be rotated by χ after time t, which we will write as $\chi(t)$. The difficulty of obtaining a physically sensible picture with this evolution is that in order to experience this unitary evolution, the observer needs to be in another reference frame, say $\chi'(t)$. However, $\hat{\mathbf{e}}$ itself is the observer's mental reference frame and there cannot be another reference frame. Similarly, in the second approach, $\hat{\mathbf{e}}$ evolves under $U^\dagger = \exp[i\sigma_y t/2]$. The vector is being rotated counterclockwise and is in $-\chi(t)$. In this case, for the observer in the reference frame of $-\chi(t)$, there needs to be an additional vector in $\chi''(t)$ in order for him to observe the evolution of $\hat{\mathbf{e}}$. Again, this is not possible because $-\chi(t)$ is not only the observer's mental reference frame but also the object that is to be observed. Therefore, in order to have a satisfactory picture of the observer observing his own reference frame's evolution, he needs another reference frame or another vector.

3 Conjecture: Experience as Being

It has been reviewed that a natural phenomenon of self-observing, as described in **(N2)**, is not consistently described by quantum theory as in other natural phenomena. Does this mean that consciousness is one special case in the universe wherein two pictures of quantum theory just don't work? It appears very strange that self-observing consciousness, being one of natural phenomena, should be different from the rest of the physical systems in nature.

Before we discuss how this inconsistency can be removed, let us first carefully examine how physical laws are derived. When an observer observes a physical system, for example, a unitary rotation of a state vector $\hat{\mathbf{v}}$, this particular phenomenon can be described in the following two statements:

(C1) The qubit $\hat{\mathbf{v}}$ is rotated about y-axis by χ.

(C2) An observer observes the rotation of $\hat{\mathbf{v}}$ about y-axis by χ with respect to $\hat{\mathbf{e}}$.

While the two descriptions **(C1)** and **(C2)** appear quite similar, it is **(C2)** that actually provides a correct description. When a physical law is derived, it is based on the description **(C2)** not **(C1)**. That is, it is impossible to obtain a physical law with the description **(C1)**, i.e., physical law cannot be obtained nor confirmed without the observer observing the natural phenomenon. The statement in **(C1)** is generally regarded as an objective statement. However, even experiments, as objective as they may seem, provide the outcome described as in **(C2)** not **(C1)**. Certainly, on most occasions, it is not necessary to describe the qubit rotation with **(C2)**, but **(C1)** is sufficient for almost all practical purposes. However, if it is to be absolutely correct, it is the **(C2)** description not **(C1)** which provides a correct description.

When an observer observes an object and perceives its shape or color etc., with regards to these perceived qualities of the object, all the observer can be sure of is that he is perceiving the object's shape or color etc. It doesn't really matter whether the object indeed has that particular shape or color, or even really exists at all. The observer simply cannot tell. All he can be sure of is that he is conscious of those perceptions. This subtlety is important in discussing the resolution to the problem of discussing self-observing consciousness and quantum theory. It is clear that the separation between the object and a measuring entity imposed by the axiom of quantum theory indicates the separation between the observer's mental state $\hat{\mathbf{e}}$ and an object being observed, $\hat{\mathbf{v}}$, as far as the natural phenomena of **(N1)** and **(N2)** are concerned. In the previous section, we reviewed that χ could be the change of the state vector $\hat{\mathbf{v}}$, i.e., in the first approach, or it could be a change of the observer's mental state $\hat{\mathbf{e}}$ as in the second approach. We also discussed that the only part the observer can be sure to exist is the observation of the change of $\hat{\mathbf{v}}$ with respect to $\hat{\mathbf{e}}$. Therefore, in order to remove the problem arising from the separation between $\hat{\mathbf{e}}$ and $\hat{\mathbf{v}}$ and knowing that the observer is only certain of the experience of the change χ, the resolution should come from identifying the observer with the experience of χ, which is stated as follows,

Conjecture: Being is the experience of observing χ and its association with time t.

As far as the natural phenomenon **(N1)** is concerned, $\hat{\mathbf{e}}$ represents the observer and $\hat{\mathbf{v}}$ represents the natural object being observed by the observer. Since this conjecture says that the experience χ does not come from a relative difference between reference frames of $\hat{\mathbf{e}}$ and $\hat{\mathbf{v}}$, it solves the inconsistency of describing self-observing consciousness described in **(N2)**, i.e., even in the absence of $\hat{\mathbf{v}}$ as in self-observing consciousness in **(N2)**, the observer could experience χ because

χ itself is being.

4 Suitable physical description

In this section, we attempt to provide a physical description which would be suitable to the conjecture made in the previous section. That is, we examine both approaches in **(A4)** such that it may yield a suitable description where it should lead to an identification of the observer, or being, with the experience of χ and its association with time t. We already discussed that the Heisenberg picture fits better since that picture describes χ as an experience rather than as a change in the state vector $\hat{\mathbf{v}}$. We would like to examine this in a little more detail so that the dynamics are consistent with our conjecture. In order to describe this peculiar phenomenon of self-observation as described in **(N2)** consistently, we will attempt to identify the observer with the experience χ and its association with time t, as stated in the conjecture, by finding a way where the observer cannot be in the reference frame $\hat{\mathbf{e}}$, although $\hat{\mathbf{e}}$ does serve the role of the reference frame when $\hat{\mathbf{v}}$ is present.

Let us make an assumption which will be helpful in the following argument. It is stated as follows: What an observer observes or experiences must be time forwarding. Note that we are only assuming that the observer's experience is time forwarding and not necessarily the whole system, i.e., including the physical system and the observer, is time forwarding. We now proceed with our argument to consistently describe self-observing consciousness. Let us re-consider the evolution of $\hat{\mathbf{e}}$ under the Heisenberg picture. Note that for the unitary operation in Heisenberg picture, it is possible to change the signs of t and σ_y while keeping the whole unitary operator the same, that is $U^\dagger = \exp[-i\sigma_y(-t)/2]$. This corresponds to the vector evolving to $+\chi$ while t is going to the minus direction compared to the previous Heisenberg case wherein the vector evolved to $-\chi$ with time going forward. In this case, we note that the observer cannot be in the reference frame $\chi(-t)$ because from the assumption that what the observer observes or experiences is only time forwarding. If the observer is in the reference frame that is moving backward in time, he would observe everything going backward in time. However, from the assumption we made, this is not possible. We therefore see that the observer cannot be in the reference frame. Since the observer cannot be in the reference frame $\chi(-t)$, this picture fits well to describe our criterion to describe self-observation. That is, rather than the observer being in the reference frame, the experience of χ defines being. Also note that although we are taking the Heisenberg picture with time going backwards, there is no problem for the observer's experience is time forwarding since we are identifying the observer with the experience χ and the observer is not in the reference frame as argued. It is interesting to note that Vitiello suggested [15] the necessity of time-reversal process in the study of consciousness.

We may consider the same trick with the Schrödinger picture evolution, that is, by putting minus signs for both time and σ_y. But in this case, it still requires an additional observer's reference frame because the observer who is in

the reference frame with time forwarding would simply observe χ in $+t$. This is similar to the way an electron in the negative energy would appear as a positron in the positive energy to an observer who is also in the positive energy. Therefore, in the Schrödinger picture, this new view still requires an additional reference frame and is not satisfactory.

5 Discussion

We have reviewed the incompatibility between self-observing consciousness and the standard axioms of quantum theory. The inconsistency arises due to the separation between the entity that performs the measurement and an object being measured. In order to remove this inconsistency we conjectured that the observer, or being, is identified with the experience of observing the object. That is, it is not the observer and an object that separately exist and the observer is observing the object in terms of the difference between reference frames, instead, the experience of observing the object is 'being' defined with χ and its association with time t. We also discussed that the suitable picture describing our conjecture is the Heisenberg picture rather than the Schrödinger picture.

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